III. SURFACE WATER ASSESSMENT

A. SURFACE WATER MONITORING PROGRAMS

The Office of Water Resources' (OWR) surface water monitoring program is designed to gather state-wide baseline data in addition to targeted monitoring information. The data is used in establishing and reviewing the state's water quality standards, to measure progress toward achieving the state and federal water quality goals, and to supply information for use in development of permit limits for wastewater discharges and Total Maximum Daily Loads (TMDL's). Current surface water monitoring programs include activities conducted by the OWR staff as well as monitoring carried out by other agencies/organizations under contracts with OWR. The surface water monitoring program consists of targeted and probability based station sites, intensive surveys, special studies, and volunteer monitoring programs.

1. Beach Monitoring Program

The Rhode Island Department of Health (HEALTH) is responsible for the licensing and regulating of bathing beach facilities in the State of Rhode Island. With help from the United States Environmental Protection Agency (USEPA), HEALTH monitors all 123 licensed beaches throughout the state. Licensed beaches include salt and freshwater, as well as public and private facilities.

Regulations require HEALTH to ensure beach water meets bacteriological standards. Water sample results are compared with the state's water quality standards for swimming, the fecal coliform standards for Class B and Class SB waters. Any beaches exceeding the criteria were resampled immediately. HEALTH has the jurisdiction to close any licensed bathing area when there is a violation of Rhode Island's water quality standards for swimming use.

Upon review of the water sample results, if any action is necessary the beach manager is notified and HEALTH's public notification procedures are followed. Current public notification procedures in place include: a 24 hour hotline; website (www.health.ri.gov/environment/beaches/index.html); and a standard press release.

2. Shellfish Growing Area Monitoring

The Shellfish Growing Area Monitoring Program is part of the State of Rhode Island's agreement with the USFDA's National Shellfish Sanitation Program (NSSP). The purpose of this program is to maintain national health standards by regulating the interstate shellfish industry. The NSSP is designed to oversee the shellfish producing states' management programs and to enforce and maintain an industry standard. As part of this agreement, the State of Rhode Island is required to conduct continuous bacteriological monitoring of the shellfish harboring waters of the State to maintain certification of these waters for shellfish harvesting for direct human consumption. Shoreline surveys are an additional requirement of the NSSP (see below). Rhode Island collects samples from 17 separate shellfish growing areas and analyzes for total and fecal coliform bacteria. These growing areas encompass all of Narragansett Bay and its shellfish harboring tributaries, all the south shore coastal salt ponds, Little Narragansett Bay, and Block Island. Each of the 17 growing areas incorporate anywhere from 11 to 39 fixed sampling stations.

Water samples are collected monthly at the 11 stations in the Upper Narragansett Bay, the 19 stations in Greenwich Bay, the 10 stations in the Kickamuit River, and the 16 stations in Mt. Hope Bay, when those conditionally approved areas are open for shellfish harvesting. The results are used to manage those conditionally approved shellfish growing areas. The other shellfish growing areas in Rhode Island are not subject to the volume and number of sewage discharges that affect the Upper Narragansett Bay or the predictable nonpoint source impact that affects the Warren and Barrington Rivers, Greenwich Bay, the Kickamuit River and Mt. Hope Bay. Accordingly, these other shellfish growing areas are monitored less frequently. Prior to March 1981, there was no regular schedule for sampling these other areas. Sampling in a particular area was done as an intensive survey on an infrequent basis. In March 1981, the sampling program was expanded and has continued through present. The emphasis has shifted to a trend-oriented monitoring program. At present, those growing areas that are approved for shellfish harvesting are sampled a minimum of six times a year. An attempt is made to sample growing areas that are prohibited to shellfish harvesting a minimum of once a year.

Phytoplankton sampling has been added to the shellfish section's routine monitoring program. This process began in July 2000 and ran through October 2000, and will continue on an annual basis as part of the section's routine sampling for the presence of fecal coliform. Protection of public health is the primary reason for this sampling. The introduction of this monitoring program will provide a basis for targeting where shellfish meats should be collected for bioassay which determines the need for the closure of shellfish grounds because of the presence of Paralytic Shellfish Poisoning (PSP) and Amnesic Shellfish Poisoning (ASP).

The role of the Office of Water Resources (OWR) is to collect two (2) phytoplankton samples during daily monitoring runs in Narragansett Bay. A memorandum of understanding between The Department of Health and the Department of Environmental Management states that the OWR shellfish section will collect an average of two (2) samples per week. The additional sampling will make up for the weeks when bay runs are unable to be completed due to foul weather or when mechanical problems arise with the monitoring boats. These samples will also serve in the creation of a Bio Toxin phytoplankton database.

Water Resources personnel collect and deliver the plankton samples to the Department of Health (DOH) Laboratory where they are analyzed and identified by food chemistry laboratory personnel. The identification is performed visually using a lab microscope, identification keys and photo's provided by The Food and Drug Administration (FDA). Three slides are prepared for each sample that is brought into the lab and the slides are examined for Alexandrium and Pseudonitzchia sp. at 100x and 250x. A sample Collection Form is filled out and a lab number is assigned to each sample submitted to the lab. The results of the identification are noted on the form and a copy is returned to the OWR and a copy is forwarded to the Office of Food Protection (DOH).

The 2003 Phytoplankton Monitoring season began the first week of April and concluded October 31, 2003. Seventy-seven samples were collected during the 32-week period from 12 different growing areas. The samples were analyzed by the Rhode Island Department of Health Food Chemistry Laboratory. No biotoxins at or above the 15 organisms per slide were identified, therefore no repeat sampling was necessary and there was no need for bioassay testing.

The data collected will be stored in the computer and will be put into a report format displaying the date, growing area, tide, water temperature, wind direction, and lab result. The sampling schedule begins in early April and will continue through October. Samples are collected at random stations from every growing area in Narragansett Bay and also for the first time in the coastal shore ponds.

3. Shoreline Surveys

Shoreline surveys are an additional requirement of the National Shellfish Sanitation Program (NSSP). These surveys are necessary to determine shellfish classification in a particular growing area and to locate all actual and potential bacterial sources. Such surveys involve an intense examination of the shoreline to identify all running pipes and tributaries for bacteriological quality as well as calculating flow rates, and then evaluating the impact upon specific growing areas. Inactive pipe sources and drainage ditches are also documented for future reference and evaluation. A shoreline survey must be performed every three years for each approved and conditionally approved growing area to meet NSSP criteria. Annual shoreline survey updates are also required each year for all approved and conditionally approved growing areas to ensure they are appropriately classified and to re-evaluate pollution sources previously identified. Water quality statistical analyses from routine sampling runs are required in conjunction with the status of any pollution sources identified during previous shoreline surveys. The Shoreline Survey Program is discussed in more detail in Chapter H – Public Health/Aquatic Life Concerns.

4. USGS Monitoring Fixed Stations

The Office of Water Resources contracted with the U.S. Geological Survey (USGS) to conduct riverine monitoring in Rhode Island. This contract ended in September 2002. Samples were collected at 7 stations described below.

Site	River	Location.
1	Blackstone	Blackstone R. at Millville, MA.
2	Branch	Branch R. at Forestdale, RI
3	Blackstone	Blackstone R. above Manville Dam
4	Pawtuxet	Pawtuxet R. at Cranston RI
5	Pawtuxet	Pawtuxet R. at Pawtuxet, RI
6	Pawcatuck	Pawcatuck R. at Westerly RI
7	Taunton	Taunton River at East Bridgewater, MA

All of the results are published in the U.S. Geological Survey publications, "Water Resources Data: Massachusetts and Rhode Island," on an annual basis. Table 3A-1 lists the analyses performed and the sampling frequencies

5. Chemical Baseline Monitoring

In 1991, to supplement the limited number of river stations monitored, RIDEM developed a cooperative agreement with URI's Civil and Environmental Engineering Department to conduct a study establishing a baseline monitoring program for the rivers of RI. During 1991, 1993, 1996, and 1998 through 2003 approximately twenty-five stations (Table 3A-2), selected from the forty-five Rapid Bioassessment Protocol (RBP) biological stations (see section III.A.6.c. below), have been monitored under this program. Water quality samples from these 25 locations are collected on a quarterly (seasonal) basis. The grab samples are analyzed for trace metals, nutrients, dissolved oxygen and other parameters (Table 3A-3). Funding problems prevented the development of a cooperative agreement with URI for this monitoring program in 1995 and 1997. Fortunately a long term agreement and funding are now in place for this project and consistent quarterly sampling of these 25 sites started in 1998.

The 25 stream stations monitored have afforded at least a limited baseline snapshot of water quality conditions where data was previously lacking. In addition, this program has allowed for a comparison of chemical water quality data with the biological assessment information from the RBP study, at these 25 sites.

Table 3A-1 Parameters measured at USGS Fixed Stations

MEASURED QUARTERLY
WATER COLUMN SAMPLING

Field determinations
- Streamflow
- Water temperature
- Specific Conductance
- pH
- Dissolved oxygen
- Alkalinity

Biological characteristics
- Fecal coliform bacteria
- E-Coli

5 day biochemical oxygen demand (BOD)

Suspended Sediments

Major nutrients

Nitrogen
- Dissolved nitrite
- Dissolved nitrate
- Dissolved $NO_2 + NO_3$
- Dissolved ammonia

Phosphorus
- Total Phosphorus
- Total orthophosphate

Total Organic Carbon (TOC)

Trace Elements

Total manganese	Total arsenic	Total iron	Total mercury
Dissolved selenium	Dissolved zinc	Total aluminum	Dissolved lead
Dissolved silver	Dissolved cadmium	Dissolved copper	Dissolved nickel
Dissolved chromium	Dissolved molybdenum		

MEASURED TWICE YEARLY
WATER COLUMN SAMPLING

Common constituents

Dissolved calcium	Dissolved chloride	Dissolved potassium	Dissolved sodium
Dissolved magnesium	Dissolved sulfate	Dissolved fluoride	

Other Constituents

Color COD Phenols, total Turbidity
ROE at 105 °C total and suspended

MEASURED ONCE YEARLY DURING PERIODS OF LOW STREAM FLOW
STREAM BOTTOM SEDIMENTS

Organic compounds

Total aldrin	Total dieldrin	Total DDD	Total DDE
Total DDT	Total endosulfan	Total endrin	Total PCB
Total PCN	Total lindane	Total heptachlor	Total mirex
Total methoxychlor	Total perthane	Total toxaphene	Total chlordane
Total heptachlorepoxide			

TABLE 3A-2 STREAM SAMPLING SITES FOR 1992 - 2001

BIOLOGICAL AND CHEMICAL BASELINE MONITORING

STREAM	TOWN	SAMPLING LOCATION	BIOLOGICAL MONITORING	CHEMICAL MONITORING
Abbot Run Brook (No)	Cumberland	Route 120	1992 - 2001	'91,'93,'96-'01
Abbot Run Brook (So)	No. Attleboro	Valley Rd.	1992 - 2001	'91,'93,'96-'01
Adamsville Brook	Adamsville	At USGS gage on Rt. 81 (Crandall Rd)	1992 - 2001	1991
Ashaway River	Hopkinton	At Rt. 216 below bridge	1992 - 2001	'91,'93,'96-'01
Bailey's Brook	Middletown	Kempenaar's Clambake (private rd)	1992 - 2001	'91,'93,'96-'01
Beaver River	Richmond	Shannock Hill Rd.	1992 - 2001	'91,'93,'96-'01
Big River	W. Greenwich	South side of Rt 3	1992 - 2001	'91,'93,'96-'01
Blackstone River	Lincoln	Below Manville Dam	1992 - 2001	-
Buckeye Brook	Warwick	Rt 117A at Lockwood Corner	1992 - 2001	-
Bucks Horn Brook	Coventry	At Lewis Farm Rd	1992 - 2001	'91,'93,'96-'01
Canonchet Brook	Hopkinton	Woodville\Alton Rd	1992 - 2001	'91,'93,'96-'01
Carr River	W. Greenwich	Burnt Saw Mill Rd	1992 - 2001	-
Chipuxet River	Exeter	Wolf Rocks Rd	1992 - 2001	'91,'93,'96-'01
Clear River	Burrillville	Victory Highway	1992 - 2001	'91,'93,'96-'01
Cold Brook	Little Compton	Pottersville Road	1992 - 2001	1991
Congdon Brook	W. Greenwich	At south side of bridge near old foundation	1992 - 2001	-
Dolly Cole Brook	Foster	Old Danielson Pike	1992 - 2001	-
Dundery Brook	Little Compton	Swamp Road	1992 - 2001	'91,'93,'96-'01
Fall River	Exeter	North of Route 165	1992 - 2001	'91,'93,'96-'01
Hardig Brook	Warwick	Toll Gate Rd near Little Gorton Pd	1992 - 2001	'93,'96-'01
Hemlock Brook	Foster	150 m W of Hemlock Rd bridge	1992 - 1995	-
Hunt River	E. Greenwich	Route 1	1992 - 2001	'91,'93,'96-'01
Jamestown Brook	Jamestown	Watson Farm Road	1992 - 1998, 2001	'91,'93,'96-'01
Keech Brook	Burrillville	At covered bridge in Geo. Washington Mgmt. Area	1992 - 2001	'91,'93,'96-'01
Kickamuit River	Swansea,MA	At Poverty Corner Road	1993 - 2001	-
Lawton Valley Brook	Portsmouth	Below Newport Res. Off Rt 114	1993 - 2001	-
Maidford River	Middletown	Prospect Avenue	1992 - 2001	'91,'93,'96-'01
Maskerchugg River	E. Greenwich	Route 1 before Goddard Park	-	'91,'93,'96-'01
Meadow Brook	Richmond	Pine Hill Rd (Carolina Management Area)	1992 - 2001	'91,'93,'96-'01
Moosup River	Coventry	At Rt 14 Bridge	1995 - 2001	-
Moswansicut Brook	Scituate	Near Rt. 116, west 80 m - below old stone bridge	1992 - 1995	-
Nipmuc River	Burrillville	South of Brook Road - Top Brk. Below pool	1992 - 2001	-
Nooseneck River	W. Greenwich	West side of Rt 3	1992 - 2001	-
Palmer River	Rehoboth,MA	At County Street	1995 - 1998	-
Parris Brook	Exeter	Blitzkreig Trail	1992 - 2001	'91,'93,'96-'01
Pascoag River	Burrillville	Grove St. bridge	1992 - 2001	'91,'93,'96-'01
Pawcatuck River	Westerly	Below White Rock Bridge	1993 - 2001	-
Pawtuxet River	Cranston	At USGS gage in Cranston	1992 - 2001	-
Queens River	Exeter	Liberty Road	1992 - 2001	'91,'93,'96-'01
Round Top Brook	Burrillville	Brook Road	1992 - 1993	'91,'93,'96-'01
Runnins River	Seekonk	At Rt 44 bridge	1993, 1995 - 2001	-
Rush Brook	Scituate	100 m W of Elmdale Bk	1992 - 1995	-
Saugatucket River	Wakefield	Rt 1A bridge	1992 - 2001	-
Silver Creek	Bristol	At Chestnut Street	1993 - 2001	-
Swamp Brook	Scituate	15 m NW of inflow pt. of Ponaganset Rv. into Scituate Res.	1992 - 1995	-
Ten Mile River	E. Providence	Broadway Bridge	1992 - 1998, 2001	-
Tomaquag Brook	Hopkinton	Chase Hill Rd	1992 - 2001	'91,'93,'96-'01
Wilbur Hollow Brook	Scituate	3 m N of culvert crossing on Old Plainfield Pike	1992 - 1995	-
Wood River	Richmond	North of Skunk Hill Rd off Old Nooseneck Road	1992 - 2001	'91,'93,'96-'01
Woonasquatucket River	Providence	Eagle Street Bridge	1992 - 2001	-

TABLE 3A-3

PARAMETERS MEASURED QUARTERLY BY URI AT BASELINE MONITORING SITES

Ammonia as N (NH_3)
Chloride
Conductivity
Dissolved Cadmium
Dissolved Copper
Dissolved Lead
Dissolved Oxygen
Fecal Coliform
Hardness
Instantaneous Flow
Nitrates as N (NO_3)
Orthophosphate as P
pH
Sodium
Temperature
Total Iron
Total Phosphorus
Total Suspended Solids
Turbidity
Unfiltered BOD_5
Volatile Suspended Solids

6. Biological Monitoring

a. General

The importance of biological assessments in the evaluation of water quality has long been recognized in Rhode Island. Biological assessments are evaluations of the biological condition of waterbodies using biological surveys and other direct measurements of resident biota in surface waters. Biological assessments are used to supplement physical and chemical water quality monitoring data. More specifically, the biological data can be used to identify long-term trends in water quality which reflect water pollution abatement efforts and/or needs. The survival of a species or aquatic community is dependent upon favorable instream environmental conditions. The effects of pollutants are evidenced in the population of organisms, species composition and diversity, and the physiological condition of natural aquatic communities.

The RIDEM, OWR uses two types of biological monitoring programs. Multiple plate artificial substrates have been used to evaluate the biological community in deep rivers since 1974. In addition, EPA's Rapid Bioassessment Protocol (RBP) has been used since 1991 for the assessment of the biological integrity of various shallow river sites in the state.

b. Artificial Substrate Monitoring

The Fullner multiple-plate artificial substrate with 14 plates has been used by DWR for 28 years to assess instream biological communities. Stations selected for this biological monitoring include those used for USGS trend chemical sampling (Table 3A-4). The purpose of this was to more closely relate chemical and biological data. This method has the advantage of providing a uniform sampling habitat for each station, thus reducing the problem caused by varying types of river bottom and depth. This sampling ended in 2002 due to the retirement of the OWR biologist who conducted the project.

Table 3.A-4 Biological River Stations (1999-2002)

BRANCH RIVER	CONTROL
Forestdale, Rt. 146A	Wood River, Skunk Hill Rd.
BLACKSTONE RIVER	
Rt. 122, Millville, MA	
Manville Dam	
PAWTUXET RIVER	
Cranston Gage	
Pawtuxet Village, Rt. 1A	
PAWCATUCK RIVER	
Westerly Gage	

c. Rapid Bioassessment Protocol Monitoring

The Rapid Bioassessment Protocol (RBP) involves an integrated assessment, comparing habitat (physical structure, flow regime) and biological measures with defined reference site conditions. From 1991 - 2001, a network of 45 stream riffle-area sites (Table 3A-2) were surveyed by Roger Williams University under contract with RIDEM. Each site was visited during the spring-summer season and macroinvertebrates are sampled (minimum 100 organisms per site visit where feasible). Data were analyzed using RBP I and II protocol which include varying degrees of field and laboratory organism identification. Data collected were compared with the reference station information to determine an assessment of the biological community.

7. Long-term Monitoring of Narragansett Bay Watershed

The Narragansett Bay Comprehensive Conservation and Management Plan (CCMP) emphasizes the importance of development of a long term monitoring program on the Bay, and includes in its objectives the pursuit of monitoring which addresses the following issues:

- Detecting long-term changes in the functioning of the Bay ecosystem.
- Assessing the influence of changing anthropogenic pollutant loadings and the success of management actions.
- Establishing baseline data to detect events such as fisheries collapse and algal blooms and their interactions with ecological disturbances.
- Provide a framework to support on-going Bay Research

While the comprehensive monitoring program envisioned by the CCMP has still not been fully realized, considerable progress continues to be made. Prior to 1998, the primary sources of water quality data on the Bay were the shellfish bacterial monitoring program, beach monitoring program and special studies in selected areas of the Bay; e.g. Providence-Seekonk River TMDL study and the National Oceanic and Atmospheric Administration (NOAA) - URI Sea Grant Greenwich Bay Initiative. However, thanks to federal seed money provided to RIDEM and URI via the NOAA Bay Window Initiative, a multi-partner Bay-wide monitoring system was initiated in 1998 through a collaborative monitoring effort including URI-GSO, RIDEM, NOAA National Marine Fisheries Service (NMFS) and EPA. Portions of this bay-wide water quality monitoring system are based on the NBEP's Comprehensive Long-Term Monitoring Plan (Narragansett Bay Monitoring Plan Final Report to the NBP, June, 1992).

In 1998, the fixed-site network of stations that collected continuous data consisted of three stations maintained by URI-GSO and two stations deployed in the Narragansett Bay National Estuary Research Reserve (NBNERR). Interest increased and the Narragansett Bay Commission (NBC), using EPA EMPACT grant funds deployed stations in the Seekonk and Providence Rivers. The stations have similar instrumentation that utilize continuous monitoring probes, usually set at two depths, to measure salinity, temperature, D.O., pH, tide height, and, for selected stations, turbidity and chlorophyll *a*.

The fixed-site network continues to be the backbone of the monitoring strategy for the Bay. Continuous measurements of parameters, most notably dissolved oxygen, are especially needed in light of the anticipated changes that will occur with the water

quality criteria for DO in marine waters. During 2004, the network expanded to an expected total of 10 stations with stations added by DEM, NBNERR and Roger Williams University. The network partners also improved coordination on issues including training, use of standard operating procedures and joint data management. All parties supported work to ensure the comparability and validity of the critical data collected from the network stations.

Looking ahead to 2005, DEM and NBNERR expect to deploy three additional stations and to continue to improve data management and accessibility. State support will be essential to the continued successful operation of the network. Refer to figure 3A-1 and table 3A-5.

Other monitoring initiatives supported via the bay Window Program include:

1. A monthly survey of the zooplankton (tiny floating animals critical to the food chain) in the Bay using an advanced computer-controlled shuttle towed behind a boat. This research is being conducted by NOAA-NMFS. The device can move up and down the water column, sampling zooplankton while simultaneously measuring depth, salinity, temperature, dissolved oxygen (D.O.), pH, and chlorophyll *a* as a tow boat covers set transects of the Bay. The present transect layout covers the Providence River, Upper Bay, Mount Hope Bay, and the East and West Passages.

2. Surface sediment samples and analyses for heavy metals and organics at 43 stations scattered around the Bay. This work has been conducted by URI-GSO.

3. Benthic Community Sampling – Conducted by URI-GSO

In addition to this water column monitoring effort, significant advances have been made through a collaborative program between NOAA NMFS Woods Hole and the RIDEM Fish & Wildlife to develop a standardized template to analyze fisheries management data in a manner that allows sharing of data between the State of R.I. and the NMFS New England fisheries management efforts. In addition, Bay Window funds provided to the RIDEM Division of Fish & Wildlife allowed replacement of its ailing trawler with a new 50 foot research vessel, the RV Chafee. Launched in spring 2004, it will now be used to conduct fisheries surveys.

The collaborative effort is intended to provide data that comprehensive picture of the present conditions of various aspects of the Narragansett Bay ecosystem. Multi-year data at the level of decades is essential to discern actual trends from normally variable measurements (e.g., dry vs. wet years often change salinity and oxygen levels but may not constitute an actual permanent shift in the Bay). Continued support, both state and federal, will be needed to sustain this critical monitoring program.

Special Monitoring for Hypoxia

In addition to the above monitoring plans, the NBEP & NBNERR organized surveys to measure overnight decreases in dissolved oxygen across the entire upper half of Narragansett Bay during 1999-2003. The surveys, conducted by volunteers, used multi-agency boat teams to cover large areas of the Bay simultaneously. This multi-

state/multi-institution dissolved oxygen survey included volunteers from the USEPA Boston, the EPA Atlantic Ecology Division Lab, EPA Lexington Lab, the Narragansett Bay Commission, RIDEM Narragansett Bay Estuary Program & NBNERR, Roger Williams University, Brown University, U.S. Fish & Wildlife, URI, Save The Bay, YSI, Inc., MACZM and others. Following the close of the 2003 sampling season, the parties involved determined that the surveys could not be sustained on a volunteer basis and the NBEP and DEM have sought to enhance the state's capability to accomplish surveys cost-effectively via the acquisition of additional equipment, etc. Surveys were conducted on a limited basis in Greenwich Bay during the summer of 2004.

The goal of the NBEP surveys is to begin first steps towards mapping a sporadic hypoxic zone that is thought to be developing at least once every two years in the upper Bay under specific meteorological conditions. The final goal is to provide data useful to the State in the preliminary ongoing TMDL for excess nutrients, especially nitrogen, to the Providence /Seekonk Rivers.

Early Results of the Bay Monitoring Program

Under the collaborative monitoring program, recent sediment data (1997-98) was acquired for 43 stations in the Bay, providing an integrated picture of recently deposited sediment pollutant loads. In addition, comparison of data from 20 of these stations with data from sediment samples taken for the original Narragansett Bay characterization study (1988-89) (and performed by the same researchers; Drs. King and Quinn, URI/GSO) provide an indication of pollutant loading trends over the last 10 years.

Results from King *et al.* (1998) show major decreases since the 1988-89 samples for trace metal concentrations in all metals analyzed in surface sediment samples taken from the most industrially-impacted areas of the Bay, the Providence / Seekonk tidal Rivers and the Taunton River (Mount Hope Bay). Stations from mid Bay areas showed little change or small increases in metals for the recent sampling, and followed the overall pollution gradient noted in the original Bay characterization study: greatest sediment pollution concentrations are always in the most industrialized/urbanized areas (e.g., Providence/ Seekonk Rivers) of the upper Bay, and decrease rapidly as one moves down bay. Measurements of Simultaneously Extracted Metal (SEM) concentrations and Acid Volatile Sulfides (AVS) indicate that the trace metals are not likely to be bioavailable at the stations with highest metal concentrations unless they become oxidized by human activities such as dredging.

The decrease in concentrations of metals in the most polluted stations from the recent (1997-8) sediment data has lowered the upper range seen in surface sediment concentrations for these metals, although highest levels are still nearest the major loading sources (major wastewater treatment facilities (WWTFs) and industrialized river mouths). This trend of decreasing metal concentrations likely reflects both the success of WWTF pretreatment programs and the decrease in the number of metal discharges from industries such as jewelry and electroplating due to the shift in the global manufacturing economy over the last 20 years. The small increases in metals in the sediments of the mid Bay areas may reflect atmospheric loadings of metals to the Bay.

For all organics analyzed (PAHs, PCBs, OCPs, TPH), concentrations in the surface sediments followed the same gradient as described above, with greatest levels

found associated with urban sources and industrialized river mouths in the upper reaches of Narragansett Bay. These organic pollutants also showed a decrease in surface sediment concentrations at many upper Bay stations since 1988-89, and significant decreases at stations closest to WWTF discharges. These results likely reflect the improvement in secondary treatment achieved over the last decade at the major WWTFs, another success story for the federal Clean Water Act, and a strong positive step towards recuperation of these areas as projected by the CCMP if treatment levels were improved at the WWTFs.

In contrast to these results, sediment nitrogen and carbon loads appear to have increased according to King *et al.* (1998), indicating that the Bay is experiencing a continued increase in nutrients and biological productivity response to those nutrients, again emphasizing the concerns over excess nutrient impacts.

Trends in Oxygen

In the aftermath of the Greenwich bay fish kill, there were a number of forums in which monitoring data with respect to dissolved oxygen was reviewed. In November, 2003, Dr. Deacutis of the NBEP presented a summary of the results of the volunteer-based hypoxia surveys to Senate oversight committees. Results indicated that several open areas of the upper Narragansett Bay and upper West Passage, Mount Hope Bay, and the western side of Greenwich Bay show evidence of low oxygen condition (<4.0 ppm) during summer months and that oxygen levels go even lower in some of these areas, reaching hypoxic levels (< 2.0 ppm) on a sporadic basis in mid or late summer over parts of the upper half of the Bay. A review of continuous measurements of dissolved oxygen and related parameters indicate that the bottom water in the Providence River, which is heavily influenced by WWTF discharges and the pollutant loadings of tributaries, is frequently anoxic during portions of the summer. This chronic condition has been the target of TMDL investigation.

In 2003, data reveal a number of instances in which the waters of the Upper Bay and Greenwich Bay indicated hypoxia. A number of factors culminated in the development of anoxic conditions in Greenwich Bay leading to the fish kill event. In 2004, there was an overall lower incidence of hypoxia that appears to be attributable to cooler air and water temperatures among other factors.

Hypoxic events may be brief (on the order of days), but can have a significant and lethal effect on sensitive bottom species in the Bay. Such events may be contributing to the quantified shift from dominant benthic fish species to a pelagic fish community in Narragansett Bay over the last decade (RIDEM Fish & Wildlife). In addition, work initiated by the NBEP has shown that eelgrass, a critical nursery habitat for young fish and crabs, was at significantly higher abundance historically, but has now been eliminated from most of the upper half of the Bay due to poor water clarity. Scientists agree that the bottom-line driving parameter for both these issues (low oxygen and poor water clarity) is the rapid growth of phytoplankton biomass in the Bay in areas receiving high loadings of nitrogen, both as ammonium and as nitrate. When these plants die, bacterial decomposition uses up much of the available oxygen in the bottom waters on very calm, hot nights in late summer, especially under conditions with even slight density stratification.

Figure 3A-1

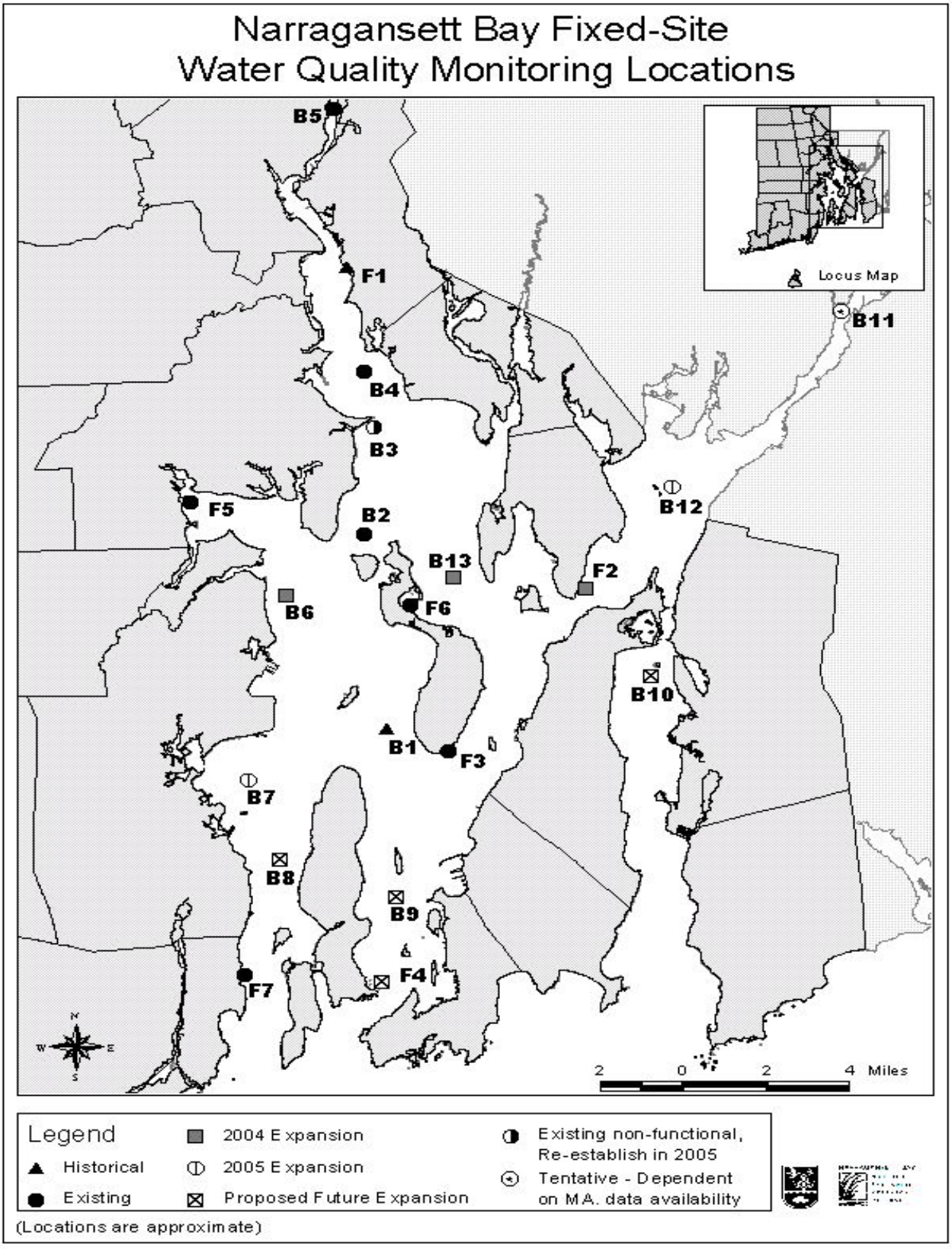
Narragansett Bay Fixed-Site
Water Quality Monitoring Locations
B5
F1
B4
B3
F5
B2
B13
F2
B6
F6
B12
B11
B10
B1
F3
B7
B8
B9
F4
F7
Locus Map
2 0 2 4 Miles
Legend
Historical
Existing
2004 Expansion
2005 Expansion
Proposed Future Expansion
Existing non-functional, Re-establish in 2005
Tentative - Dependent on MA. data availability
(Locations are approximate)

Table 3A-5 Narragansett Bay Fixed-Site Water Quality Monitoring Locations

Map Label	Location	Station Type	Agency Servicing Station	Status	2004 Deploy Date	Data History	Comment
Stations Operational for Summer 2004							
B5	Phillipsdale/ Seekonk River	Dock	NBC	Current	April	April 2003 - present	Seasonal
B4	Bullock's Reach (lower Providence River)	Buoy	NBC	Current	April	July 2002 - present	Seasonal
B2	N. Prudence	Buoy	GSO	Current	June 3	July 1999- present	Seasonal
B13	Poppasquash	Buoy	DEM-OWR	New	July 7	New	Seasonal
F5	Greenwich Bay (Greenwich Bay Marina)	Dock	NERR	Current	April	June 2003 - present	Year-round
B6	Mount View	Buoy	GSO	New	July 3	New	Seasonal
F6	Potter's Cove	Dock	NERR	Current	N/A - January	Dec 1995- present	Year-round
F3	T-Wharf	Dock	NERR	Current	N/A - January	July 2002- present*	Year-round
F7	URI GSO Dock	Dock	GSO	Current	N/A- January	June 1994 - present	Year-round
F2	Roger Williams U.	Dock	RWU	New	Pending	New	
Planned Expansion of the Network Funded for 2005							
F1	Pomham Rocks	Dock	NBC	Historical; future upgrade			
B3	S. Conimicut Point	Buoy	GSO	Historical; replaced w/ new station in 2005			
B12	Mt. Hope Bay	Buoy	TBD	New			
B7	Quonset Point	Buoy	TBD	New			
F4	Fort Wetherill	Dock	DEM – F&W	New			
Future Expansion Needs							
B10	Sakonnet River	Buoy	TBD	New			
B11	Upper Mt. Hope Bay (Massachusetts)	Buoy	TBD	New			
B8	Lower West Passage	Buoy	TBD	New			
B9	Lower East Passage	Buoy	TBD	New			

NBC – Narragansett Bay Commission
DEM- Department of Environmental Management; OWR= Office of Water Resources; F&W – Division of Fish & Wildlife
GSO – University of Rhode Island Graduate School of Oceanography
NERR – Narragansett Bay National Estuarine Research Reserve
RWU – Roger Williams University
* Data is available from September 1996 – July 2002 from a nearby location.

8. TMDL Development – Water Quality Assessment Projects

The state's 303(d) list identifies the state's impaired waterbodies and provides a scheduled time frame for development of Total Maximum Daily Loads (TMDLs), also known as water quality restoration plans. The goal of the state's TMDL program is to develop and implement water quality restoration plans aimed at restoring impaired waterbodies to an acceptable condition that meets water quality standards and supports the waterbodies' designated uses (e.g. fishable and swimmable condition). Through the TMDL development process, water quality conditions are more thoroughly characterized and pollution sources identified providing the technical basis for the pollution abatement actions specified in the water quality restoration plans. Development of TMDLs can take over two years - typically including at minimum one year of data collection and the remainder of the time in data analysis, report writing, and review by EPA and the public. The 303(d) list's Group 1 identifies those waterbodies where TMDL development is currently underway (or expected to be initiated within two years of the 303(d) list publication). A brief synopsis of the TMDL development projects presently being conducted or overseen by the Department is provided below:

a. Providence-Seekonk Rivers

The Providence and Seekonk Rivers are estuaries located at the head of Narragansett Bay, forming the principal tributary to the Narragansett Bay. The Providence River is formed by the confluence of the Woonasquatucket and Moshassuck Rivers in downtown Providence. The Providence River merges with the Seekonk River at Fox Point at the head of Providence Harbor. The Seekonk River starts in Pawtuxet, where the Blackstone River flows over two dams into tidal waters. The Seekonk River flows approximately 8 km through the cities of Pawtucket, Central Falls and East Providence, to Fox Point in Providence where it flows into the Providence River. From Fox Point, the Providence River flows to the south a distance of 12 km to Conimicut Point, emptying into upper Narragansett Bay.

Since the late 1980s it has been recognized that WWTFs are a significant source of nutrients to the Providence and Seekonk Rivers and Upper Narragansett Bay. Excessive nutrient levels result in large algae blooms, large daily oscillations in dissolved oxygen, and violations of the minimum dissolved oxygen standards established to protect aquatic life. Beginning in 1995, RIDEM began work to address these water quality problems through the development of a TMDL. To begin, a study characterizing source loadings and the present condition of the system was performed by RIDEM during 1995 and 1996. RIDEM then hired a consultant to develop a water quality model to predict the reduction in nutrients necessary to meet water quality standards. In 1997, RIDEM formed a technical advisory committee (TAC) to provide additional expertise and guidance throughout the development of the model. Over the past year, it has been determined that the model can't be successfully calibrated. There was general agreement by the TAC that further data collection would not improve the model and that a better model framework is simply not available.

During preliminary efforts to calibrate the model, the TAC recommended that RIDEM incorporate the MERL tank experiment results to improve the model's representation of phytoplankton growth and die-off. Consistent with that recommendation, and in the absence of a successful water quality model, RIDEM looked to the MERL tank experiments as a model to predict the impacts of

nitrogen reductions on dissolved oxygen and phytoplankton levels. In the Winter/Spring of 2004, RIDEM produced a report, "Evaluation of Nitrogen Targets and WWTF Load Reductions for the Providence and Seekonk Rivers" documenting this approach. Based upon this analysis and with consideration of the implementation costs and an analysis of the performance of available technology, RIDEM has developed a phased plan for implementation of WWTF improvements with the goal of reducing nitrogen loadings to the Upper Bay by 50%.

b. Palmer Estuary System

The Palmer River estuary is listed as impaired for nutrients, in addition to fecal coliform – for which a TMDL has been completed and approved by USEPA. The loading of nutrients produces high seaweed accumulations that cover the bottom of the lower River, which in turn cause large fluctuations in dissolved oxygen in the River, with supersaturated daytime levels and low night-time levels. The condition results from nutrient loadings released by permitted discharges in downstream reaches of the Warren River and upstream loadings in the watershed. The shallow water depths of the lower Palmer River exacerbate the condition. Field work in support of the nutrient TMDL was conducted during the1996 – 1998 period. Progress in completing the TMDL has been impeded by the lack of staff in the program; the nutrient TMDL is scheduled for completion by the end of 2005.

c. Woonasquatucket River

The Woonasquatucket River watershed is located in the north-central part of Rhode Island. The river is approximately 19 miles long, from its headwaters in the Town of North Smithfield to its confluence with the Moshassuck River in downtown Providence (downstream of Waterplace Park). Along its course, the Woonasquatucket River flows through various ponds and reservoirs, and from Rising Sun Dam in Olneyville to its confluence with the Moshassuck River, it is tidally influenced. Historically, the surface waters within the Woonasquatucket River have been impounded by dams for drinking water supply, recreational purposes and for water supply to the mills for industrial purposes. Currently, there are 40 impoundments within the watershed identified by RIDEM/RIGIS database.

Like the Blackstone River, the Woonasquatucket River was heavily used by mills during the 19th century and has been altered by its historical heritage. The four segments of the Woonasquatucket River are listed as impaired by at least one of the following parameters: phosphorus, excess algal growth/chl-a, biodiversity impacts, mercury, PCBs, dioxins, pathogens, copper, lead, and cadmium.

RIDEM began assessments of the area in 1998. Dry weather sampling was completed in 2001, and working with various partners including the Narragansett Bay Commission and The Louis Berger Group (under contract to RIDEM), wet weather assessments were completed in 2002. Following up on an earlier US EPA survey that identified 317 outlet pipes to the river, RIDEM staff also conducted exhaustive shoreline surveys of the area that identified a host of issues including sewage leaks, dry weather CSO discharges, illicit discharges, and poor pollution prevention practices. RIDEM initiated more than a dozen complaints with the Office of Compliance and Inspection as a result of the pipe surveys.

Progress in completing the TMDL was impeded by the lack of staff in the program, however, work resumed in 2004 as new personnel joined the group. DEM is presently in discussion with Region 1 on a final TMDL approach. In the mean time, DEM has continued to work with the Woonasquatucket River Watershed Council, the Narragansett Bay Commission, the DEM Offices of Technical and Customer Assistance and Compliance and Inspection, the DEM RIPDES Program, and the RIDOT to plan BMPs that include improved monitoring and maintenance of the CSO system, stormwater treatment systems, and improved hazardous materials handling and disposal practices through a combination of voluntary and enforcement measures in concentrated source areas.

d. Sakonnet River at Portsmouth Park and The Cove at Island Park

The Sakonnet River (Portsmouth Park) and The Cove (Island Park) are coastal waters located in the Narragansett Bay watershed along the northeast coastline of Aquidneck Island and the Town of Portsmouth, Rhode Island. These waters have both been identified as impaired by fecal coliform. The impaired portion of the Sakonnet River (Portsmouth Park) are the waters north of a line extending from the southwestern-most corner of the stone bridge in Tiverton to the eastern-most extension of Morningside Lane in Portsmouth, encompassing 180 acres. The impaired area designated as The Cove (Island Park) encompasses 109 acres in the area referred to as Blue Bill Cove, and is delineated by a line from the southern end of Hummock Point to the RIDEM range marker located at the eastern extremity of a point of land on the western shore of The Cove.

In 1986, a shoreline survey of the area by the Rhode Island Department of Environmental Management's (RIDEM) Shellfish Program documented direct discharges of groundwater seeps and storm drain outfalls contaminated by human sewage. As a result, these waters were closed to shellfishing due to the potential public health risk associated with these discharges. Though available water quality data at nearby offshore monitoring stations located in the Sakonnet River and the southern portion of "The Cove" indicates safe swimming conditions, the identified discharges are variable in nature and may cause localized areas of contamination, the extent of which is unknown. Consistent with established Department of Health policy to not swim within 200 feet of stormwater discharges, individuals are advised to also avoid swimming in the vicinity of areas where water seeps from the ground. Because the waters potentially affected cannot be explicitly defined, the shellfish closure area may be used as a guide.

A final Fecal Coliform TMDL document has been prepared by RIDEM and submitted to US EPA for approval. The objective of this phased TMDL for the Sakonnet River (Portsmouth Park) and The Cove (Island Park) is the elimination of all discharges of untreated and inadequately treated wastewater including illegal discharges, illicit connections to stormdrains, and contaminated groundwater seeps. RIDEM has coordinated with the Town of Portsmouth to ensure that the findings of the TMDL are addressed in the Town's Wastewater Facilities Plan and Phase II Stormwater Management Plan.

e. Saugatucket Pond and Indian Run Brook

Saugatucket Pond is listed as impaired for phosphorus and noxious aquatic

plants. RIDEM conducted water quality monitoring on Saugatucket Pond for total phosphorus during the summer of 2000. RIDEM's water quality assessment found that phosphorus levels did not violate the water quality standard, and that noxious aquatic plants present in the pond were the result of shallow depths and enriched sediments that allow aquatic plants to thrive. Since the noxious aquatic plants impairment is not due to a "pollutant," an aquatic plant management plan is being prepared in lieu of a TMDL. The aquatic plant management plan is expected to be complete in 2005.

f. Blackstone River

The Blackstone River is an important natural, recreational, and cultural resource to both Rhode Island and Massachusetts, extending 48 miles from its headwaters in Worcester, Massachusetts to its point of discharge into the Seekonk River in Pawtucket, Rhode Island. It is a major source of freshwater to Narragansett Bay. The majority of this 454 mi^2 watershed lies in Massachusetts. The river is the site of the nation's first textile mill, Slater's Mill, built in 1793 and was heavily used by mills through the 1800's. The river was altered by its industrial heritage and though the river's water quality has improved dramatically, the main stem of the Blackstone River continues to be listed for bacteria, copper, lead, biodiversity impacts, ammonia, nutrients, and low dissolved oxygen.

In 2001, RIDEM contracted with The Louis Berger Group to characterize water quality conditions and pollution sources causing impairments of the Blackstone, Mill, and Peters River, Valley Falls Pond, and Scott Pond, in support of the development of TMDLs for each waterbody. In January 2002, key stakeholders in the watershed were brought together to form a Technical Advisory Committee (TAC) to provide additional review of key project deliverables as they are completed by the contractor and submitted to RIDEM. The first phase of the assessment project, to compile existing water quality and pollution source data including land use data for the Rhode Island portion of the Blackstone River watershed and to identify data gaps, was completed in the Spring of 2004.

The primary goal of the second phase of the TMDL is to obtain the information needed to develop TMDLs for the identified impairments. Because the Blackstone River is also a major nitrogen source to the Providence and Seekonk Rivers (listed as impaired for nutrients (nitrogen), low dissolved oxygen, and excess algal growth/chlorophyll-a), data to assess nitrogen loading and attenuation will also be collected. Additionally, phosphorus data will be collected to support assessment of biodiversity impacts, future NPDES permit issuance and the significance of phosphorus loading from the Blackstone River on the Valley Falls and Scott Ponds impairments.

A comprehensive water quality monitoring plan has been developed and preparation of the QAAP is nearing completion. The comprehensive monitoring effort is expected to begin in Fall 2004 and continue for a 12-month period. The final phase of the project entails data analyses and determination of necessary load reductions. It is anticipated that the final report characterizing water quality in the targeted waterbodies will be completed and submitted to RIDEM in 2007. This report will serve as the technical basis of the resulting TMDLs to be

developed by RIDEM staff.

g. Sands Pond

Sands Pond is located on Block Island in the town of New Shoreham, Rhode Island. Sands Pond is a "kettle hole" pond, essentially a reflection of the islands' groundwater. There are no channelized inflows or other discharges to the pond other than mechanical withdrawal for water supply or seepage through its bottom or sides. The pond is approximately 14.7 acres with an average depth of approximately 7 feet. The Block Island Water Company formerly withdrew water from the pond to supply residents of New Shoreham. Though BIWC maintains a water treatment plant on the northern shore of the pond, it is currently drawing water from a system of six adjacent wells and not the pond. It is RIDEM's understanding that at the present time Sands Pond would only be used during high demand periods as a backup to the existing system of wells.

Under RIDEM's Water Quality Regulations (RIDEM, 1997), Sands Pond is designated as a Class A waterbody, suitable as a source of public drinking water supply, for primary and secondary contact recreational activities and for fish and wildlife habitat. Because Sands Pond is designated as a public drinking supply water, it is also designated as a Special Resource Protection Water (SRPW). RIDEM's Water Quality Regulations define SRPW as those waters that are high quality surface waters having significant ecological or recreational uses.

The relatively small watershed of approximately 74 acres is developed as open space, meadows, farmland, forestland or low-density single-family residential (120,000 sq. ft. minimum lots). There is a mix of sewered and non-sewered areas within the watershed, but all of the residential uses are currently serviced by individual sewage disposal systems (ISDSs). The water treatment plant discharges filter effluent to the town's sewer system, which is treated and discharged offsite. The treatment plant does not have sanitary facilities

Sands Pond has been identified as impaired for excess algal growth, taste and odor, turbidity, and phosphorus, with the primary parameter of concern being phosphorus since it is the limiting nutrient for algae growth in freshwaters. RIDEM conducted water quality monitoring and land use assessment during the summer of 2001. Elevated levels of phosphorus were observed in the water column and in the sediment. The current external phosphorus sources to Sands Pond are non-point in nature and include atmospheric deposition, groundwater, and waterfowl. These sources are balanced annually by the net settling of phosphorus to the sediments through death of water column algae. The settling term is a net value that reflects the balance between the sinking of detrital phytoplankton into the bottom and the recycling of re-mineralized (inorganic) phosphorus back into the water column. RIDEM is finalizing preparation of the TMDL documenting its findings and recommendations for restoring the pond to a condition that supports its designated uses.

h. Mashapaug Pond

Mashapaug Pond is a 77-acre pond located in the Pawtuxet River basin, within an area locally known as Reservoir Triangle in the southwest corner of the City of Providence. The pond has a long history of development along its banks dating back as early as 1636 when it was included in Roger William's original

land purchase from the Narragansett Indians. The approximate 4,860 acre watershed is an area with mix of older industrial and residential development, with a ratio of approximately 2 acres of residential use to every 1 acre of industrial use.

The pond is identified as impaired by nutrients and hypoxia, with the primary parameter of concern being phosphorus since it is the limiting nutrient for algae growth in freshwaters. Data collected in the late 1990's by volunteer water quality monitors participating in the URI Cooperative Extension's Watershed Watch program found the pond to be impacted by excessive phosphorus related problems including poor water clarity, chlorophyll a levels considered to be highly eutrophic, and low dissolved oxygen levels in the bottom waters.

In 2001, RIDEM partnered with EPA to hire a contractor, Tetra Tech, to develop a TMDL for the Pond. The consultant monitored the pond and its tributaries during both wet and dry weather conditions, characterizing current water quality conditions and pollutant sources to the pond. The consultants also applied a water quality model to estimate phosphorus loads to the pond and the pond's capacity to assimilate pollutant loads. The model was used to determine needed pollutant reductions. Working from the consultant's final report, RIDEM has prepared a draft TMDL which in addition to establishing pollutant load reductions, also identifies necessary control actions. RIDEM anticipates that the document will be made available to the public for review in late fall/winter 2004.

i. Ninigret and Green Hill Ponds

The Charlestown lagoon system, located on the southern coast of Rhode Island, consists of two major basins, Ninigret Pond (6 km long and 1.4 km wide) and Green Hill Pond (1.5 km long and 1.4 km wide). Both of these shallow coastal lagoons are micro-tidal estuaries, receiving restricted tidal flushing through a narrow man-made breachway. Ninigret Pond is located entirely within the Town of Charlestown and is bounded on its northern side by Route 1 and the Charlestown end moraine. Green Hill Pond is located primarily in the southwestern corner of the Town of South Kingstown, with a small portion of the pond extending into southeastern Charlestown. Green Hill Pond and the eastern portion of Ninigret Pond are permanently closed to shellfishing and, as a result, are identified as impaired for pathogens. Two of Green Hill Pond's largest tributaries, Factory Brook and Teal Brook, are also considered impaired due to pathogens.

From 1999 through 2001, RIDEM conducted field reconnaissance, assessed land use, and monitored water quality in the impaired areas of the pond and their watersheds. RIDEM also conducted a DNA based bacterial source tracking study in September and October 2002 in an effort to discern dry and wet weather sources of fecal coliform bacteria to the pond. The draft pathogen TMDL prepared by RIDEM reports on the findings of this field work and includes recommendations to abate the identified pollution sources. The draft TMDL was made available to the public for review and comment in the summer of 2004. RIDEM is in the process of responding to comments, and preparing the final TMDL document for submittal to US EPA for approval.

The South Shore Salt Ponds Watershed Restoration Plan, administered by RIDEM's Office of Sustainable Watersheds, will identify the necessary steps to implement the pathogen TMDL recommendations including conceptual designs for treating stormwater discharges, and will identify any additional pollution sources and/or control actions necessary to address the low dissolved oxygen impairment on Green Hill Pond.

j. Greenwich Bay waters

Greenwich Bay is a shallow embayment located in Narragansett Bay, partially sheltered by Warwick Neck to the north and Potowomut Neck to the south. The bay covers approximately 4.6 square miles (12 km2) and includes five major coves: Warwick, Brush Neck, Buttonwoods, Apponaug, and Greenwich. Its watershed encompasses portions of the City of Warwick and the Towns of East Greenwich and West Warwick, Rhode Island Greenwich Bay provides vital shellfish habitat, shoreline access, and boating opportunities, among other benefits to the citizens of Rhode Island. Greenwich Bay is home to three licensed bathing beaches: Goddard Park, Oakland Beach, and City Park, and over 4000 boats moored or docked primarily at marinas in three coves - Apponaug, Greenwich, and Warwick. During the winter months when inclement weather makes harvesting shellfish more difficult in Narragansett Bay, local commercial shellfisherman rely on the Greenwich Bay shellfish resource to supplement their annual harvest.

Greenwich Bay, Brush Neck Cove, Buttonwoods Cove, Warwick Cove, and Greenwich Cove are identified as impaired by pathogens, nutrients, and low dissolved oxygen. Additionally, Hardig Brook, Tuscatucket Brook, Maskerchugg River and seven smaller tributaries to Greenwich Bay are identified as impaired for pathogens on the state's 303(d) list.

Prior to 1992, harvesting shellfish from Greenwich Bay was approved - regardless of precipitation, with some resource management restrictions. Following heavy rains and snow in December 1992, Greenwich Bay was first temporarily closed and then in January 1993, permanently closed for shellfish harvesting until a reclassification study of the waters could be completed. Greenwich Bay was reopened as a Conditional Area in June 1994 following the completion of the reclassification study conducted jointly by DEM and FDA during the spring and summer of 1993. Currently, harvesting shellfish is prohibited in Greenwich Bay for seven days following a rain event that exceeds 0.5 inches. Dry weather closures in the Class SA areas of Greenwich Bay include Brush Neck Cove, Buttonwoods Cove, and an area of Greenwich Bay directly adjacent to Apponaug Cove.

RIDEM has completed a draft TMDL addressing the fecal coliform impairments to the Greenwich Bay waters. The TMDL aims to restore Greenwich Bay waters by identifying necessary pollutant reductions, locating pollution sources, and outlining an implementation strategy to abate fecal coliform sources such that water quality standards can ultimately be attained during all weather conditions. The draft TMDL was made available to the public for review and comment in the winter of 2004. RIDEM is in the process of responding to comments, and preparing the final TMDL document for submittal to US EPA for approval.

Through the RI Coastal Resources Management Council's Special Area Management Planning Process strategies for addressing Greenwich Bay's nutrient related impairments are being developed.

k. Kickemuit River

The Kickemuit River watershed extends northeast from Rhode Island into portions of the towns of Swansea and Rehoboth, Massachusetts. Its waters in Rhode Island include the Lower Kickemuit Reservoir (also known as the Warren Reservoir) and a tributary referred to as the Upper Kickemuit River or western tributary, located in the Town of Warren. The Kickemuit River extends north into southeastern Mass, to its headwaters at the Warren Reservoir in the Town of Rehoboth. The watershed is comprised principally of forest (42.4% of it area), with significant agricultural (16.5%) and residential (16.0% medium to medium high density and 6.6% medium to low density).

Waters in Rhode Island, including the Kickemuit Reservoir, the Kickemuit River, the Western tributary (Upper Kickemuit River) and the two unnamed RI tributaries are designated as Class A waters, suitable as a source of public drinking water supply, for primary and secondary contact recreational activities, and for fish and wildlife habitat. The main stem of the river and tributary streams and reservoirs on the Massachusetts portion of the watershed are designated as Class B waters. These waters are designated as habitat for fish, other aquatic life, and wildlife, and for primary and secondary contact recreation.

With the exception of the Warren Reservoir near its headwaters in Massachusetts, all reaches of the Kickemuit River and its impoundments in Rhode Island and Massachusetts exceed water quality standards for fecal coliform bacteria. The main stem of the river in Rhode Island is also impaired for Total Phosphorus. The Kickemuit Reservoir on the lower reach of the river, which serves as a water supply impoundment, has been identified as being impaired for turbidity and taste and odor problems since the early 1990s.

Starting in 2000, RIDEM began a partnership with EPA Region 1 to develop nutrient and bacteria TMDLs. US EPA hired a contractor to provide water quality monitoring and modeling services. Field studies and modeling identified septic systems, wildlife, stormwater, and agricultural activities as significant contributors. RIDEM incorporated implementation recommendations into a draft TMDL, which was forwarded to MADEP for further modification in 2004. Submission to EPA and the public comment process are scheduled for the winter of 2005.

l. Future TMDL Projects

RIDEM proposes to adopt an approach used by other states for multiple waterbody phosphorus TMDLs for twelve ponds located, with a few exceptions, in urban areas throughout Rhode Island: Gorton Pond, Warwick Pond, Spectacle Pond, Roger Williams Park Pond, Almy Pond, Brickyard Pond, Upper Dam Pond, Sand Pond, Prince's Pond, Hundred Acre Pond, North Easton Pond, and Belleville Pond. The TMDL approach will involve using existing water quality data largely collected by volunteer monitors participating in the URI Cooperative

Extension's Watershed Watch Program, current land-use information, and literature-derived phosphorus loading information to establish present and potential future loadings. Land use information available from RIGIS coverages may be combined with literature-derived loading rates to establish existing pollutant loadings and the present water quality status of the waterbody when no water quality data exists. RIDEM will follow lake phosphorus methodologies developed by Region 1 staff, and will work with US EPA to resolve a suitable approach for setting load reductions and allocations. These TMDLs are scheduled for completion by December 2007.

Other waterbodies, scheduled for completion of TMDLs in the 2005 – 2007 time period, for which only preliminary level of assessment work has been initiated include: Point Judith Pond, Wickford Harbor, Potter Cove, Mt. Hope Bay, Kickemuit River estuary, Tidal Pawcatuck River, Little Narragansett Bay, Three Ponds and Three Ponds Brook.

m. Approved TMDLs

To date, seventeen TMDLs have been approved by US EPA. RIDEM is mandated by the federal Clean Water Act to prepare TMDLs for the state's impaired waterbodies, however much of the responsibility of implementing the TMDLs falls upon municipalities – with the most costly pollution control actions being upgrades to municipal wastewater treatment facilities and stormwater treatment systems. Private property owners also have a role to play in restoring the state's waters and certain TMDLs have specifically identified the need for corrective actions on private property. In addition, watershed councils and other non-profit organizations play a vital role in gaining popular support by educating the public as to the need for the various corrective actions and in implementing these water quality initiatives. Once the necessary corrective actions have been identified and a TMDL is completed, RIDEM works with other state and federal agencies, municipalities, watershed organizations, and private property owners to implement the TMDLs recommendations. A listing of approved TMDLs is shown in Table 3A-6.

Table 3A-6 Approved TMDLs

Waterbody	Parameter	Date approved by US EPA
Stafford Pond	Nutrients/ Excess Algal Growth/Low DO	March 1999
Hunt River	Pathogens	January 2001
Scrabbletown Brook	Pathogens	January 2001
Fry Brook	Pathogens	January 2001
Palmer River	Pathogens	May 2002
Runnins River	Pathogens	September 2002
Barrington River	Pathogens	September 2003
Narrow River including Mumford Brook	Pathogens	April 2002
Gilbert Stuart Stream	Pathogens	April 2002
Crooked Brook	Pathogens	February 2003
Saugatucket River	Pathogens	August 2003
Mitchell Brook	Pathogens	August 2003
Indian Run Brook	Pathogens	August 2003
Rocky Brook	Pathogens	August 2003
Yawgoo Pond	Phosphorus/ Excess Algal Growth/Low DO	June 2004
Barber Pond	Low DO	June 2004
Chickasheen Brook	Noxious Aquatic Plants/Phosphorus	June 2004

9. Citizens' Volunteer Monitoring

Citizens' volunteer monitoring has long been an important environmental monitoring force within Rhode Island. Its popularity is reflected in the growing number of citizens' volunteer monitoring groups and in the increased number of volunteers and monitoring stations being added to existing citizens' monitoring groups.

RIDEM is represented on the Rhode Island Volunteer Monitoring Steering Board which is an advisory board that oversees volunteer (citizen) monitoring activities around the state. The board facilitates communication between individual citizen groups and has strengthened communication between citizen groups and the state and federal agencies which use their data. Since RIDEM no longer has a fulltime Citizen Monitoring Coordinator position, representation on this board has assisted RIDEM in maintaining an outreach approach with these groups.

The OWR utilizes the data collected by the various Citizen Monitoring groups in the water quality assessments conducted for the 305(b) report. Furthermore, the monitoring data is used as a screening tool to alert the OWR to problem areas where the Department needs to conduct sampling and take action.

10. Quality Assurance

Environmental Protection Agency (EPA) policy requires participation by all EPA regional offices, program offices, EPA laboratories, and states in a centrally managed Quality Assurance (QA) Program. As part of the QA Program, each state is required to develop a QA Program Plan and QA Project Plan(s) for assuring the reliability of monitoring and measurement data. RIDEM has developed a Quality Management Plan (QMP) to formally communicate that commitment and establish a process to ensure it is met. The QMP covers all of the data generation, data collection and management activities in the Offices of Air Resources, Compliance and Inspection, Water Resources, Waste Management, and Technical and Customer Assistance. In addition, Quality Assurance Project Plans (QAPPs) are developed for various projects conducted by and for the OWR.